NUMERICAL INVESTIGATION OF LATTICE WEINBERG - SALAM MODEL

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Abstract. Lattice Weinberg - Salam model without fermions for the value of the Weinberg angle $\theta_W \sim 30^o$, and bare fine structure constant around $\alpha \sim \frac{1}{150}$ is investigated numerically. We consider the value of the scalar self coupling corresponding to bare Higgs mass around 150 GeV. We investigate phenomena existing in the vicinity of the phase transition between the physical Higgs phase and the unphysical symmetric phase of the lattice model. This is the region of the phase diagram, where the continuum physics is to be approached. We find the indications that at the energies above 1 TeV nonperturbative phenomena become important in the Weinberg - Salam model.

The investigation of finite temperature Electroweak phase transition [1] requires nonperturbative methods. The phase diagram of the lattice Weinberg-Salam model at zero temperature also contains the phase transition. It is expected, that the continuum physics is approached in some vicinity of this transition. Basing on an analogy with the case of finite temperature Electroweak phase transition we suggest the hypothesis that the nonperturbative effects may become important close to the phase transition of the zero temperature model, i.e. at high enough energies (above about 1 TeV). This justifies the use of lattice methods in investigation of this model. We indeed obtain some results that support the mentioned hypothesis. Here we report these results. In our investigation we restrict ourselves by the following bare values of couplings: fine structure constant $\alpha \sim \frac{1}{150}$, the Weinberg angle $\theta_W = \pi/6$, the Higgs boson mass $M_H \sim 150$ GeV. From the previous analysis [2] we know that the renormalized values of α and M_H do not deviate essentially from their bare values. We consider the model without fermions. We exclude the first order phase transition because we do not observe any sign of a two - state signal. Also we find the indications that the second order phase transition is present. The ultraviolet cutoff is increased when the phase transition is approached.

We consider three different effective constraint potentials. For their definition see [2]. The three mentioned above effective potentials give three different definitions of the scalar field condensate (as the value of ϕ, where the potential $V(\phi)$ has its minimum). In Fig. 1 we represent these three condensates as functions of the cutoff.

Also we calculate the percolation of the Nambu monopoles and the Z - strings. We observe the condensation of Nambu monopoles and Z - strings for $\Lambda > 1$ TeV and the deviation of the calculated values of the scalar field condensates from the expected value $2M_Z/g_Z \sim 273$ GeV for the values of Λ around 1 TeV. We consider these results as indications that nonperturbative effects become

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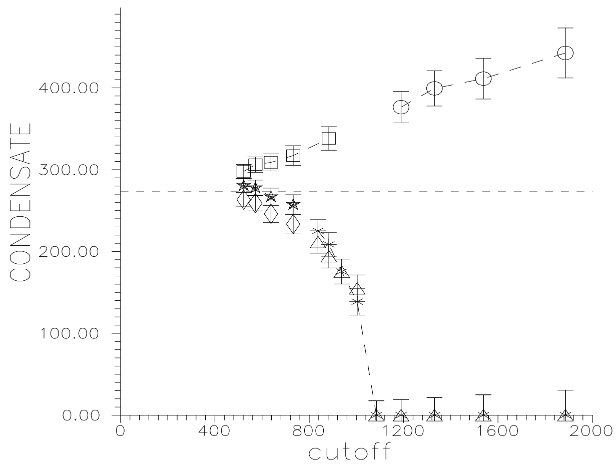

Figure 1: The scalar field condensate (in GeV) as a function of the cutoff for $\lambda = 0.0025$, $\beta = 12$. Circles correspond to the UZ potential, lattice $16^3 \times 32$. Squares correspond to the UZ potential, lattice $8^3 \times 16$. Crosses correspond to the UDZ potential, lattice $16^3 \times 32$. Stars correspond to the UDZ potential, lattice $8^3 \times 16$. Triangles correspond to the ultraviolet potential, lattice $16^3 \times 32$. Diamonds correspond to the ultraviolet potential, lattice $8^3 \times 16$.

important in lattice Weinberg - Salam model for the value of the cutoff above about 1 TeV.

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